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Waterfowl Inventory and Wetlands Enhancement Summary 1992

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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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1.0 INTRODUCTION

In 1968 the W.A.C. Bennett Hydro Dam was constructed on the Peace River. Flooding of the Williston Reservoir Basin consequently followed and resulted in the loss of fifteen hundred square kilometres of prime wildlife habitat. Winter range and migration corridors were lost and habitat within the Williston Reservoir Basin was impacted. As a result of these changes, populations of many species were notedly reduced.

To compensate for the loss of wildlife habitat, in 1988 B.C. Hydro provided a perpetual fund to finance the Williston Wildlife Compensation Program (WWCP). The WWCP is a program designed to enable B.C. Hydro and B.C Environment to cooperate in wildlife enhancement projects. The WWCP follows guidelines which recognize the need to gain biologically sound information about habitat selection patterns and seasonal movements of wildlife species inhabiting the Williston Reservoir Basin. The information acquired through studies provides the foundation for habitat and/or population enhancement projects.

Waterfowl, both breeding and migrating populations, were affected by the flooding of the Williston Reservoir Basin. To compensate for changes in the availability of cover, forage, and nesting areas the WWCP has planned projects for wetland areas. To ensure that appropriate enhancement techniques are implemented the WWCP has conducted waterfowl inventories and habitat assessments for the past two years. The initial wetland enhancement for waterfowl involved a pothole blasting project in October 1990. This project was designed to evaluate blasting requirements and determine water retention capabilities of the potholes. In the spring and summer of 1991, Corbould (1991) conducted a waterfowl inventory, studied habitat suitability, and identified areas with enhancement potential. Following the evaluation of key wetland areas in the Parsnip drainage, four nesting islands were established in the Mackenzie area and recommendations were made for enhancement projects to be carried out in the future.

In 1992, a waterfowl inventory was conducted at wetlands previously identified as having enhancement potential, or considered to be valuable breeding areas. Also, information gathered from waterfowl inventories and wetland evaluations made it possible to identify appropriate enhancement locations and techniques. These enhancements were employed to increase the availability of breeding areas and quality of habitat at selected wetland areas.

The objectives of this report are to provide a summary of the 1992 wetland inventory and to compare these results to the 1991 wetlands inventory. This report will also summarize the enhancement projects carried out to date and propose future wetland enhancement projects.

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2.0 WETLAND INVENTORY AND ASSESSMENT

2.1 STUDY AREA AND METHODS

The main study area included two bays on the Parsnip Arm of Williston Lake. These bays are located within 10 km of Mackenzie and are relatively accessible (Figure 1). Corbould (1991) identified specific wetlands of the Mugaha Bay area as having moderate to high enhancement potential. He placed nesting islands at two of the wetlands in Mugaha Bay (Mugaha A and Mugaha G) and described Mugaha B as having "... the best waterfowl habitat (feeding, nesting, and brooding) within the study area". Corbould (1991) identified two wetland areas in Tutu Bay as having moderate enhancement potential. He placed a nesting island in Tutu Bay itself and another island was installed at Tutu B, a small marsh close to Tutu Bay.

Additional study areas included (1) a chain of five small lakes between Tutu Bay and Mugaha Bay (Figure 1), (2) two sites from the 1990 enhancement trial (Site 1 [Mischinsinlika foreshore] and Site 2 [Buth marsh]), (3) the Mischinsinlika foreshore, and (4) the section of Gatalga Creek which intersects Highway 39 (Figure 2).

From May 12 to July 16 (except for the week of June 21 to June 27) weekly inventories were taken at Mugaha A, B and G, and at Tutu A and B. Other wetlands within the study area were surveyed a variable number of times: Mugaha C (5), Tutu L (6), Tutu Bay (3), Tutu I (3) and Mugaha Bay (1). The lakes area was surveyed twice and Mischinsinlika foreshore was surveyed once. Sites 1 and 2 were surveyed at the beginning of the study to determine water levels. Gataiga Creek was surveyed occasionally but extreme water fluctuations were evident and it was not considered to be an appropriate study site.

Surveys were conducted between the hours of 7:00 am and 12:00 pm (noon). However, due to poor accessibility, portions of the lakes area and Tutu Bay were surveyed later in the afternoon. Waterfowl decrease feeding in midday and during warmer temperatures. As a result, viewing was not optimal and counts were low. Binoculars and a spotting scope were used to observe waterfowl at a distance while the shoreline of the bays and marshes were walked. Wetland use by non-waterfowl wildlife species were also noted during walks of wetland perimeters.

On-site water analyses were conducted at certain sites to determine their suitability for enhancement. Parameters measured included alkalinity, hardness and pH.

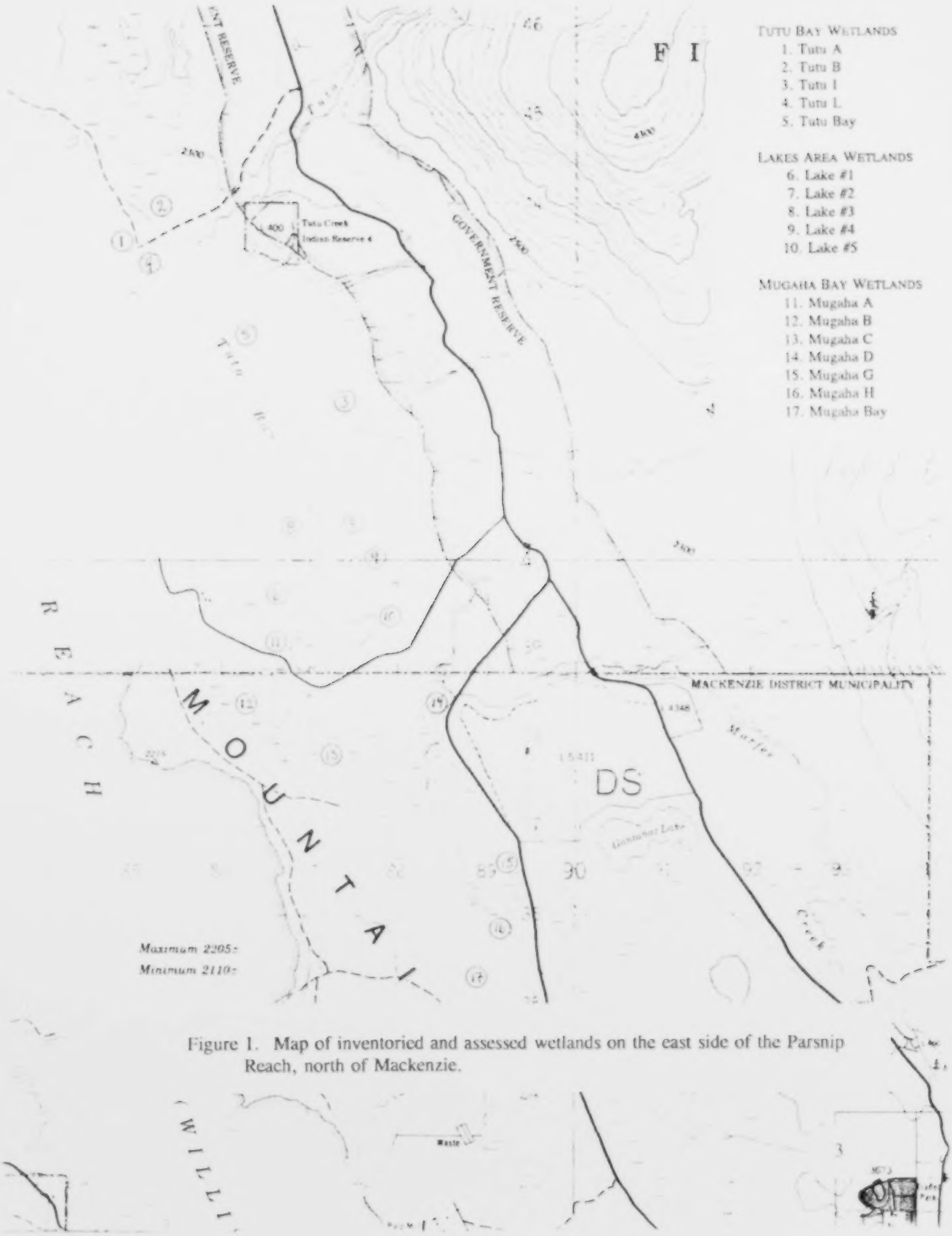

Figure 1. Map of inventoried and assessed wetlands on the east side of the Parsnip Reach, north of Mackenzie.

Figure 2. Map of inventoried and assessed wetlands at the south end of the Parsnip Reach, south of Mackenzie.

2.2 RESULTS AND DISCUSSION

Waterfowl inventory results are presented in Table 1 and an estimate of breeding pairs and broods are listed in Table 2. [Waterfowl abbreviations follow guidelines of British Columbia Provincial Museum (Appendix 1)]. The estimates of breeding pairs were derived using Ducks Unlimited guidelines (Appendix 2) and by analysing trends in the inventory data from 1991 and 1992. A comparison between 1991 (Corbould 1991) and 1992 inventory results for total waterfowl use, breeding pairs and broods are provided in Table 3. Sightings and sign of other wildlife are described in Table 4. A summary of species observed for important wetland sites is also provided in Enhancement Projects (Section 3.3).

2.21 Mugaha Bay Area

Mugaha A: A pair of CAGO were observed using the nesting island up to May 20 and then were not observed at the site. A pair of COLO nested on a sedge mat at the south end of the lake and produced one offspring. One of the adult loons was found dead of unknown causes on July 16 (the mate and juvenile were last seen on July 7). A pair of ospreys occupied a nest in the timber on the west side of the main pond, a brood was observed only on June 3. A beaver was observed at its house in the south end of the lake. In the spring a beaver dam was affecting water levels in the far east pond but by July the water had dispersed and the area was dry. Signs of bear and moose were observed along the eastern perimeter of the lake. Water tests taken on May 20 found the lake had a pH of 7.5, alkalinity of 51.3 mg $CaCO_3$/L, and a hardness of 51.3 mg $CaCO_3$/L.

Mugaha B: This was the most productive wetland in the study area; several species of waterfowl were observed at inventory (see Table 1). Breeding waterfowl consisted of 7 pairs of CAGO, two pairs of RNDU, three pairs of AMWI, three pairs of MALL, two pairs of BUFF, and two pairs of goldeneyes. The only broods observed were those of the BUFF and goldeneyes. This marsh was a feeding and resting area to BWTE, GWTE, CITE, NOSH, NOPI, REDH, CANV, AMCO, COME, HOGR, and COLO. Species of shorebirds frequently observed in the area were Bonaparte's Gulls, Black Terns and Lesser Yellowlegs. Moose were commonly observed feeding in the marsh and there were signs of bear throughout the upland area around the marsh. Water chemistry analysis on May 20 measured pH at 7.8, alkalinity at 85.5 mg $CaCO_3$/ L and hardness at 85.5 mg $CaCO_3$/L.

Mugaha C: Waterfowl use of this marsh was not significant. No breeding pairs were observed in the vicinity of the marsh and only the occasional CAGO was observed foraging near the marsh. While upland grasses and sedges *(Carex spp.)* were common, pondweeds *(Potamogeton spp.)* and smartweeds *(Polygonum spp.)* were not abundant and the lack of these forage species at the site could be responsible for the its lack of use.

Mugaha G: A pair of CAGO nested on the floating PVC island and produced a single gosling. They were observed from early May until June 11 and appeared mainly to be using the North end of the pond. Occasionally a COLO, RNDU, MALL, and BAGO were observed feeding on the lake. As Williston Lake levels reached 669m, seepage into Mugaha G resulted in increased waterlevels.

Table 1. Waterfowl inventory results (May - June, 1992).

LOCATION	DATE	CAGO	RNDU	AMWI	MALL	BWTE	BUFF	BAGO	COLO	OTHER WATERFOWL SPECIES
Gataiga Creek	May-20	3	2							
Lake #1	Jun-04									
	May-20						2			
Lake #2	May-19									
	May-20									
	Jun-04									
	Jun-19									
Lake #3	May-19	2								
	Jun-04									
Lake #4	May-20						1			
Lake #5	May-20	2			2		2		1	
	Jun-19						1			3 unidentified females
Mochinsnlika	May-20	36								
Mugaha A	May-08	2		2					2	
	Jun-11								3	
	May-12	2							2	
	May-28									
	Jun-03			4	4				1	REHE (2)
	Jun-19								2	
	Jun-30								1	COLO (1 Cl. 1B)
	Jul-07								2	COLO (1 Cl. 2A)
	May-20	2					4			GWTE (2)
Mugaha B	May-08	3	6	14	6	1	11	7		NOPI (4), GWTE (3), CANV (3)
										NOSH (3), AMCO (1)
	May-12	14	2	19	9	1	4	3		GWTE (6), NOPI (2), COME (2),
	May-20	7	5	26	11	1	20	4		CITE (1), GWTE (3)
										NOSH (15), HOGR (1), NOPI (1)
	May-28	5		3			3	2		
	Jun-03		7				2			GWTE (3), AMCO (1)
	Jun-11		9	3			2	4		REHE (2)
	Jun-19		2				1			AMCO (1), BUFF (7 Cl. 1C)
	Jun-30					2	1	2		BAGO (3 Cl. 2C & 10 Cl. 3)
										BUFF (4 Cl. 2A)
	Jul-07			1			2			BUFF (8 Cl. 1B & 11 Cl. 3)
	Jul-16			1			2	5		BAGO (3 Cl. 2B & 11 Cl. 3)
										BUFF (11 Cl. 2C)
Mugaha Bay	Jun-03	4			2					
	May-12	1								
Mugaha C	May-08	1								
	May-12									
	Jun-03									
	Jun-11									
	Jul-07									
Mugaha D	May-08	6								COME (2)
	May-12	5								COME (2)
Mugaha G	May-08	4			2					COME (1)
	May-12	2			2				1	
	May-28	2								
	Jun-03	4								
	Jun-11	2								CAGO (1 Cl. 1C)
	Jun-19							2		
	Jun-30		4							
	Jul-07									
Mugaha H	Jun-03	11						4		CAGO (5 Cl. 1A)

Table 1 (cont'd). Waterfowl inventory results (May - June, 1992).

LOCATION	DATE	CAGO	RNDU	AMWI	MALL	BWTE	BUFF	BAGO	COLO	OTHER WATERFOWL SPECIES
Parsnip River	May-20									
Tutu A	May-08			10						GWTE (5)
	May-28									
	Jun-09	8								
	Jun-19									
	May-12	9			3					GWTE (2)
	May-20									
	Jun-03	16								
	Jun-30									
Tutu B	May-12	4	2							
	May-20	3	3							SUSC (1), REHE (1)
	May-28	1			2					
	Jun-03	2			2					
	Jun-09									
	Jun-19						1			
	Jun-30									
	May-08	2	4		2	2				HOME (2)
	Jul-07									
Tutu Bay	May-19	7							1	SUSC (10)
	Jun-09	10							1	HOME (4), CAGO (>15 Cl. 1-2A)
										CAGO (6 Cl. 2A)
Tutu C	May-12									
	May-19									COME (1)
	Jun-09									
Tutu I	May-19									
Tuty Islands	May-19	3								GWTE (2), SNGO (9)
Tutu J	Jun-09									
Tutu K	May-19	2								
Tutu L	May-08							2		COME (1)
	May-12									GWTE (3), COME (3), HARL (2)
	May-28	10								HOME (6)
	Jun-03	4								
	Jun-09									
	Jun-30									

Mugaha H: On June 3, eleven CAGO were traversing the shoreline with a brood of five Class IB goslings. This brood was probably from Mugaha J. Also on June 3 four female BAGO were observed feeding in the pond.

Mugaha J: No geese were observed on June 3 but signs of geese were apparent. Possibly the brood at Mugaha H was produced at Mugaha J.

2.22 Lakes Area

Lake 1: Two male BUFF were observed on the northwest side of the lake on May 20. Water chemistry tests on May 20 found the lake to have a pH of 7.2, alkalinity of 51.3 mg of $CaCO_3$/L, and a hardness of 51.3 mg of $CaCO_3$/L.

Lake 2: No waterfowl was observed on Lake 2 during any of the inventories. An American Kestrel was observed on two occasions and a cow moose was observed on the west side of the lake on June 4. Samples taken on May 20 found the pH of the lake to be 7.6, the alkalinity to be from 94.1 to 102.6 mg $CaCO_3$/L, and the hardness as 85.5 mg $CaCO_3$/L.

Lake 3: On May 19 two CAGO were observed swimming at Lake 3 and were thought to possibly nesting, however, no geese were observed on June 4.

Lake 4: On the one occasion this lake was surveyed, a single male BUFF was observed. The lake was determined to have a pH 7.4, alkalinity of 68.4 mg $CaCO_3$/L and a hardness of 68.4 mg $CaCO_3$/L.

Lake 5: A pair of CAGO and a pair of BUFF were observed nesting on May 20 but by June 19 the geese had disappeared. Other waterfowl observed on the lake were MALL and COLO. The pH of the lake on May 20 was 7.6 and the alkalinity and hardness were 119.7mg of $CaCO_3$/L.

Table 2. Waterfowl breeding pairs and broods observed within the study area.

LOCATION	ESTIMATED BREEDING PAIRS (BROODS OBSERVED)								COMMENTS
	CAGO	RNDU	AMWI	MALL	BAGO	BUFF	COLO	HOME	
Mugaha A							1(1)		COLO (1 Cl. 2A)
Mugaha B	7(0)	2(0)	3(0)	3(0)	2(2)	2(2)			BUFF (8 Cl. 1B, 11 Cl. 3) BAGO (3 Cl. 2B, 11 Cl. 3)
Mugaha Bay	2(0)			2(0)					pairs not displaying nesting behavior
Mugaha G	1(1)								CAGO (1 Cl. 1C)
Mugaha H									CAGO (5 Cl. 1A), probably only feeding in area
Tutu B	2(0)			1(0)		1(1)		1(0)	CAGO were observed nesting upto June 3 BUFF (14 Cl. 1A)
Tutu Bay	4(2)								CAGO (>15 Cl. 2A, 6 Cl. 2A)
Lake #4						1(0)			Male BUFF observed (May 20), but lake was not surveyed again.
Lake #5	1(0)					1(0)			CAGO pair nesting on May 20, however, they were not observed on June 19. Male BUFF was observed on small pond.

2.23 Tutu Bay Area

Tutu B: Two pair of CAGO were observed nesting at the lake; one pair was nesting in the SE corner and the other was using the wooden floating island. They were observed until June 3, however, there were no signs of broods at either nest. In addition, pair of MALL and a pair of HOME were nesting at the lake and no brood was observed from either pair. One BUFF brood (Class IA) was observed at the lake on June 19 and BUFF were only observed on the lake at one other time. Water tests conducted on May 20 determined the pH of the lake to be 7.9, alkalinity to be 119.7 mg $CaCO_3$/L, and hardness to be 119.7 mg $CaCO_3$/L.

Tutu Bay: Four pairs of CAGO and two broods were observed in Tutu Bay. Other waterfowl observed in the area of Tutu Bay includes SUSC, COME, HOME, GWTE, SNGO and HARL. Shorebirds occurring in this area were the Lesser Golden-plover, Semipalmated Plover, Greater Yellow-legs, Killdeer, Short-billed Dowitcher and Lesser Yellow-legs. Signs of wolves, moose, coyote and beaver were observed. Osprey, Bale Eagles, and American Kestrels were frequently sighted in the Bay and eagle nest is located at the entrance to Tutu I.

2.24 Summary

In summary, several waterfowl species were observed using the wetlands in the study area. However, certain species were observed regularly and were observed breeding in the study area. The most commonly observed species included the CAGO, RNDU, AMWI, MALL, BAGO, BUFF, COLO, and COME. The breeding waterfowl in the study area have a variety of nest types. For example, CAGO, MALL and AMWI are upland nesters, RNDU and COLO nest over-water, and BAGO, BUFF and COME nest in cavities. While the nesting habits of these species might have affected their visibility during the inventory, the surveys were usually carried out prior to mid-day when at least the male would be feeding in open water areas. As a result, estimates of breeding pairs should accurately represent the breeding populations at the study sites.

Other species observed during the waterfowl surveys included BWTE, GWTE, CITE, HOGR, HOME, NOSH, NOPI, CANV, SUSC, REDH, SNGO (blue phase), and AMCO. These species were not observed on a regular basis and are considered to be migrants in the study area.

At most of the study sites, waterfowl inventory were similar to last year, however, a few changes occurred. The BWTE pairs observed last year at Mugaha C and Mugaha B were not nesting or using the areas for feeding this year. One possible explanation for this lack of appearance is that their flyway did not extend into the study area this year. BAGO appeared at Mugaha B this spring and 2 pairs raised broods there. In 1991 BAGO was not observed at any of the study sites and this year they were not only observed at Mugaha B, but also at Mugaha G, Mugaha H and Tutu B. BAGO has been shown to displace BUFF from nesting cavities by aggressive behaviour (McLaren 1969); this might explain the decrease in BUFF broods and appearance of BAGO broods at Mugaha B. COLO pairs were sighted at Mugaha

A, Mugaha G and Tutu Bay last year. While an individual loon appeared at Mugaha G this year, the only pair observed was at Mugaha A. While the pair did reproduce, the juvenile and one adult did not survive.

In addition to differences in the waterfowl populations using the study area, several new shorebird species were observed. Lesser golden-plovers were observed throughout the Tutu area and on the Mischinsinlika foreshore. These birds were observed feeding in shoreline areas where log debris provided some cover. Except on the Peace lowlands, spring sightings of migrating lesser golden-plover are not common in the interior (Campbell et al 1990). Semipalmated plovers, also migrants, were observed feeding along the shore throughout the Tutu area, on the Mischinsinlika foreshore and at the Parsnip River. Several short-billed dowitchers were observed feeding in shallow pool in Tutu Bay and at Tutu C.

Table 3. Comparison of 1991 and 1992 waterfowl inventory results.

LOCATION	1991	1992
Gataiga Crk	RNDU pair	RNDU (no pairs, but 2 females) (fluctuating water levels due to dam removal and beaver activity)
Mugaha A	more CAGO later in the summer TRSW pr COLO pair and brood observed	 no TRSW COLO (pair & young), 1 adult died, mate disappeared in July
Mugaha B	fewer CAGO pairs fewer AMWI pairs no BAGO observed MALL broods observed BWTE common 1EUWI 1 LESC 1 RNGR no AMCO	 no RNDU broods observed 2 BAGO pairs & broods BUFF (1 pair less & 2 fewer broods) MALL not observed after May 20 BWTE rare no EUWI no LESC 1 HOGR 1 AMCO
Mugaha C	no nesting waterfowl	BWTE pair
Mugaha G	MALL pair COLO pair no CAGO pair, but 1 brood feeding	no MALL pair 1 COLO CAGO pair & brood on floating island
Mugaha H	CAGO pair, no brood	CAGO (pair & brood)
Lake #4	MALL pair observed BUFF pair and brood observed	no MALL observed male Buff observed
Lake #5	CAGO pair (left in June), no brood obs. BUFF (male) observed	CAGO pair (left in June), no brood obs. BUFF pair
Tutu B	2 pair CAGO, no broods obs. no BUFF observed HOME pair, no brood obs. MALL pair, no brood obs.	2 pair CAGO, no broods obs. BUFF pair and brood HOME pair, no brood obs. MALL pair, no brood obs.
Tutu Bay	COLO pair no CAGO pairs observed	no COLO pair CAGO (4 pairs & 2 broods)

Table 4. Non-waterfowl species observed within the study area.

SPECIES	ABUNDANCE	DISTRIBUTION
FURBEARERS		
Beaver	common	Sightings at Mugaha A, G and J and Lake #3; sign throughout.
Muskrat	rare	Feeding sign at Mugaha C.
River otter	rare	Tracks observed at Lake #3.
LARGE MAMMALS		
Black bear	rare	One observed near Tutu B and signs at Mugaha A,B, C and the lakes.
Moose	common	Observed at Tutu B, Mugaha A & B, Lake 1 and sign throughout.
Wolf	rare	Signs throughout Tutu Bay
Coyote	rare	Sighting at Tutu A and signs throughout.
RAPTORS		
American kestrel	occasional	Sightings in Tutu Bay,Mugaha A & C and at Lake 2.
Bald eagle	rare	Adult near a nest at Tutu G, adults at Mugaha G and Tutu Bay .
Osprey	common	Brood in nest at Mugaha A and sightings near Mugaha C and Tutu J.
Northern harrier	rare	Sighting of adult at Mugaha C.
Red-tailed hawk	rare	Sighting of 2 adults at Tutu B.
Great horned owl	rare	Sighting at Tutu A; in timber near clear cut.
Great grey owl	rare	Sighting at Buth Marsh.
SHOREBIRDS		
Bonaparte's gull	common	Sightings at Mugaha A & B , Lake 5 and Tutu Bay.
Glaucous-winged gull	rare	Sighting at Tutu B.
Black tern	common	Sightings at Mugaha A & B.
Common snipe	common	Sightings in the Mugaha area and at Gataiga Creek.
Lesser yellow legs	common	Sightings throughout study area; nesting at Mugaha A,B & C.
Greater yellow legs	occasional	Primarily in the Tutu Bay area but also observed at Mugaha C.
Killdeer	occasional	Sightings along Tutu Bay shoreline.
Lesser golden-plover	occasional	Sightings at Tutu Bay, Tutu A & C, and Mischinsinlika.
Sandhill cranes	rare	Observed once at Tutu A.
Semipalmated plover	occasional	Observed at Tutu C & A, Tutu Bay, Mischinsinlika and Parsnip River.
Shortbilled dowitcher	rare	Several observed in Tutu Bay near the penninsula and at Tutu C.
Sandpiper sp.	occasional	Seveal species in Tutu Bay area.
Lapland longspur	rare	Tutu islands.
Water pipets	rare	Sighting at Tutu Bay and Tutu A and Gataiga Creek.
PASSERINE BIRDS		
American robin	common	Common throughout all areas of the study area.
Red-winged blackbird	common	Very common at Mugaha B & C and sightings thoughout study area.
Northern rough wing swallow	rare	Single sighting of 8 feeding at Tutu C.
Tree swallow	common	Very common throughout study area, using birch snags for nests.
Violet-green swallow	common	Very common throughout study area, using birch snags for nests.
White-crowned sparrow	rare	Infrequent sightings on deciduous vegetation.
Yellow-crowned sparrow	occasional	Infrequent sightings on deciduous vegetation.
Yellow rumped warbler	occasional	Occasional sightings
Dusky fly catchers	occasional	Sightings at Tutu bay and Lake 4.
Townsend's solitare	rare	Single sighting at Mischinsinlika; using a small snag for a perch.
Lincon's sparrow	rare	Sighting at Tutu A.
Wilson's warbler	rare	Sightings at Mugaha A & I, and Tutu A
OTHER BIRDS		
Belted kingfisher	occasional	Observed throughout the Mugaha and Tutu areas and at Lake 5.
Raven and Common crow	occasional	Periodical sightings along Tutu and Mugaha shorelines.

3.0 ENHANCEMENT

3.1 ENHANCEMENT TECHNIQUES

Several techniques are currently recognized as options for enhancing, rehabilitating and maintaining wetland areas as waterfowl habitat. The limitations and benefits of each technique must be taken into account and the suitability of a technique for a specific wetland evaluated. In addition, enhancement effort must be targeted for an appropriate group of waterfowl. For instance nestboxes would not be utilized to improve the nesting habitat of over-water nesters. Available techniques include: burning, damming, dynamite blasting, earthen islands (pimpling), floating nesting islands, hay bales, level ditching, loafing logs, nestboxes, and planting/ seeding. Following is an account of each of these techniques with a brief description of their benefits and the groups they target. The information in this section has been adapted from Corbould (1991).

BURNING

The burning of a wetland area can accomplish two enhancement objectives. It removes vegetation which retards the growth of desirable young lush vegetation. As a result the preferred species become available for grazing CAGO. A three to five year interval is recommended for grass rejuvenation (Schemnitz 1980). Also with the way it removes the dense ground cover burning can be used to prepare a site for subsequent seeding or planting programs.

DAMMING

Manipulation of water levels in wetlands is possible by damming. Damming is a means of creating suitable water levels on a yearly or a long term basis. By changing the time and length of drawdown and inundation the plant species composition and waterfowl species in the area can be controlled. For example, feeding habitat for dabbers can be created by maintaining water levels at < 1 m in depth during spring and summer. The same wetland is suitable winter habitat for muskrats and beaver if the water levels are kept at deeper levels (> 1 m) in the fail and winter.

DYNAMITE BLASTING

Dynamite blasting is an alternative to heavy duty machinery for creating depressions and level ditching. Dynamite blasting can be used to create small depressions or ditches in areas which are not accessible to machinery or for projects where it is not cost effective to use machinery. Ideally blasting should be done in areas where the substrate consists of firm organics with a base layer of sand, gravel or clay. The charges are set in such a way that a depression 2 m deep is created. This depth ensures a gently sloping depression which waterfowl and aquatic furbearers can utilize. Breeding or migratory waterfowl could forage in the area after aquatic vegetation has and invertebrates have colonized the depression or ditch. Aquatic furbearers could store a winter cache in the ditch or depression because it will not freeze to the bottom.

EARTHEN ISLANDS/ PIMPLING

Earthen islands are a "natural" solution in an area where there is a shortage of nesting areas for ground nesting waterfowl or no loafing areas in shallow water. This technique uses a

backhoe to pile spoil from ditches into mounds through out the wetland. As a result of the soil removal a deep water area is established around the islands. This makes predator access to the islands is more difficult. The ditching also provides appropriate feeding habitat for diving and dabbling ducks. Muskrats also benefit from the earthen mounds as they are potential burrowing sites for houses. Earthen island should be monitored to ensure that Canadian thistle does not colonize the mounds and make the islands less acceptable to waterfowl, and that wave action does not erode the islands to the point where no island remains.

FLOATING NESTING ISLANDS

Currently two types of nesting islands are being utilized by Ducks Unlimited in the area: 1) a seven square foot wooden platform, 2) five square foot PVC platform. To provide nesting material the wooden platforms have soil and grass seed placed on them when they are installed in the wetland. Although the design of the wooden island encourages the growth of vegetation to provide a perpetual source of nesting material, they need to be monitored annually to ensure that the vegetation is growing. The PVC platforms are piled high with cattails *(Typha latifolia)* which provide excellent nesting material but need to be restocked annually to be adequate for nesting. The platforms provide nesting habitat for CAGO and loafing areas for ducks. Ducks Unlimited anticipates the production from floating platforms to be 0.5 geese/island/year and 0.2 ducks/island/year. Placement location for the floating islands is important in producing a successful nesting site (see nesting islands in enhancement section). It has not yet been determined if floating islands implemented at these northern climates can withstand ice movements and retain the life span (6 to 10 years) of islands placed in areas of less severe climatic conditions.

LEVEL DITCHING

Ditching meets several wetland enhancement objectives. Water can be rerouted and distributed in a desirable way. As a result of improved water distribution more aquatic vegetation becomes available as forage and cover for waterfowl and aquatic furbearers. Continuous deep channels lined with emergent vegetation such as a cattails and sedges allows ease of movement, act as brooding corridors and feeding areas. Spoil material piled on to the ditch's edge in mounds provides nesting and loafing sites for waterfowl and burrowing areas for muskrats.

LOAFING LOGS

Loafing logs provide a stationary offshore loafing or resting area. Their construction may involve a single 4m log anchored in open water. A loafing log can be modified into loon nesting site by securing two logs together and adding nesting material such as sedges.

NESTBOXES

Nestboxes provide artificial nesting sites for cavity nesting waterfowl such as buffleheads, Mergansers, Goldeneyes and Wood Ducks. Factors which affect site selection for a nestbox include: orientation to sunlight and prevailing winds, proximity to the water's edge and other nestboxes, availability of feeding and loafing areas, and several others. Nestboxes last for roughly 7 years but they must be checked annually to ensure that adequate material (i.e., wood chips) remains. Ducks Unlimited estimates 3.4 ducks/box.

SEEDING

Seeding can be used to increase food or cover for aquatic furbearers and waterfowl. Introducing species such as pondweeds and smartweeds would provide forage for divers and dabblers whereas transplanting cattails would supply over-water nesting waterfowl with nesting sites and would provide muskrats with their preferred food source.

PLANTING

Planting deciduous vegetation, such as alder, increases forage available for beaver and it can be used to create a protective boundary around exposed wetlands.

3.2 MONITORING

In order to create ponds for waterfowl habitat two sites were selected for blasting in 1990. The ponds (or potholes) created by the blasting at Site 1, on the Mischinsinlika foreshore, were considered to be shallower than ideal at the time of the blasting. Observation of Site 1 on May 20 found that one pothole was dry and the other had approximately 40 cm of water but that grass was encroaching on the depression. Waterfowl was utilizing the foreshore area but not the potholes. The blasting at Site 2 in Buth Marsh produced five potholes approximately 1 - 2m deep. The results obtained in this blasting project were considered very effective in terms of labour required and the results produced. On May 20, examination of the 5 potholes created at Buth marsh revealed the following:

1) 70% water cover, maximum depth 40cm
2) 95-100% water cover, maximum depth 30cm
3) 95-100% water cover, maximum depth 50cm
4) 90-100% water cover, maximum depth 20cm
5) 20% water cover with grass in southern half, maximum depth 15cm

No waterfowl or signs of waterfowl were observed near the potholes at Site 2, although these potholes were expected to attract migrating or breeding waterfowl.

In 1991 four floating nesting islands were purchased and placed at Tutu B, Tutu Bay, Mugaha A and Mugaha G. These islands were installed to increase the nesting habitat available to Canada Geese or other waterfowl species and to serve as loafing areas. Floating PVC and wooden islands were utilized to allow for fluctuating water levels and access difficulties. Wooden islands were placed at Tutu Bay and Mugaha A awhile PVC islands were placed at Tutu B and Mugaha G. The only island at which a brood of Canada Geese was actually observed at is Mugaha G. Geese were also observed nesting at Tutu B, and Mugaha A, however no broods were observed at these sites. Although no geese used the nesting island at Tutu Bay for nesting, on one occasion geese were observed loafing on and around the island. Comparison of the use of PVC and wood islands indicates that the PVC islands are preferred. However, the PVC islands are possibly located in more preferred habitat than the wooden islands. At this point in the enhancement program a generalization can not be made as to which the most suitable type of island for Canada Geese nesting in the Williston area.

All of the islands withstood water level fluctuations and ice break-up and by the end of the breeding season grass was growing well on the islands at mugaha A and Tutu Bay. PVC

islands at Mugaha G and Tutu B needed to be restocked with cattails. And the pulley system on the wooden island at Tutu Bay needed to be checked to ensure that it was operating properly.

3.3 ENHANCEMENT PROJECTS

3.31 Enhancement Sites

During the waterfowl inventories, wetlands within the study area were evaluated for their enhancement suitability. Using the results of these evaluations and information from previous years, including sites outside the study area, sites were selected for enhancement. The following is a brief description of site characteristics for these selected enhancement sites.

60 KILOMETRE MARSH
Waterfowl observed: LESC, BUFF.
Other wildlife observed: black bear, osprey, and beaver sign.
Aquatic vegetation: sedges, *Eleocharis palustris*, smartweed, pondweed, horsetails *(Equisetum spp.)*, and waterlily *(Nuphar lutea polysepala)*.
Water chemistry: pH 8.0, alkalinity and hardness 119.7 mg $CaCO_3$/L.
Existing habitat: sedge and smartweed provides excellent over-water cover, upland grasses available for foraging geese, and a large forested island could serve as a resting site (but is not suitable for nesting).

MUGAHA B
Waterfowl observed: CAGO, RNDU, AMWI, MALL, BUFF, goldeneyes, BWTE, GWTE, CITE, NOSH, NOPI, REDH, CANV, AMCO, COME, HOGR, and COLO.
Other wildlife observed: moose and bear sign.
Water chemistry: pH 7.8, alkalinity and hardness 85.5 mg $CaCO_3$/L.
Existing habitat: feeding habitat for diving ducks, dabblers and upland grazers is available. Sedge fingers interspersed with open water provide cover. Nesting areas for ground nesters are adjacent to the marsh.

TUDYAH NORTH
Waterfowl observed: BAGO (2 female, 2 Class IIB).
Other wildlife observed: moose and beaver sign.
Aquatic vegetation: sedges, coontail *(Ceratophyllum demersum)*, pondweed, smartweed, bur weed *(Sporangium sp.)*, Potamogeton, waterlily, horsetails.
Water chemistry: pH 8.0, alkalinity and hardness 153.9 mg $CaCO_3$/L.
Existing habitat: 2 loafing logs exist, some natural cavities are present as indicated by the goldeneye brood. In addition, a slough across the road could serve as a feeding area.

MISINCHINKA MARSH
Waterfowl observed: none.
Other wildlife observed: beaver sign.
Aquatic vegetation: bladderwort *(Utricularia sp.)*, *Calatriche sp*., sedges.
Water chemistry: not tested.
Existing habitat: adjacent grass meadow area could be used by foraging CAGO.

WAPOOSE LAKE
Waterfowl observed: 1 COLO.
Other wildlife observed: none.
Aquatic vegetation: sedges, cattails, coontail, milfoil *(Myriophyllum spp.)*.
Water chemistry: pH 8.0, alkalinity and hardness 273.6 mg $CaCO_3$/L.
Existing habitat: excellent cover and over-water nesting habitat in the cattails and sedges along the marsh perimeter.

ROBERTS POND
Waterfowl observed: 1 WEGR.
Other wildlife observed: none.
Aquatic vegetation: sedge (submergent vegetation not evaluated).
Water chemistry: not tested.
Existing habitat: open water with sedge along perimeter.

MUGAHA A
Waterfowl observed: AMWI, MALL, CAGO, COLO.
Other wildlife observed: beaver, moose and signs of bear.
Aquatic vegetation: sedges, smartweed, Potamogeton.
Water chemistry: pH 7.5, alkalinity and hardness 51.3 mg $CaCO_3$/L.
Existing habitat: sedge feeding area to the east of the lake and smartweed and Potamogeton growing throughout the lake serve as a food source. A floating sedge mat provides a nesting area for nesting loons. Sedges also provides nesting cover for ground nesters.

TUTU B
Waterfowl observed: CAGO, MALL, BUFF, SUSC, RNDU, REDH (1 male).
Other wildlife observed: beaver, moose, coyote and bear.
Aquatic vegetation: not evaluated.
Water chemistry: pH 7.9, alkalinity and hardness 119.7 mg $CaCO_3$/L.
Existing habitat: nesting and foraging habitat for CAGO. Feeding areas for diving ducks.

3.32 Enhancement Methods

NESTBOXES
Seven wetland areas were selected for nestbox placement (Table 5) and 24 nestboxes were purchased from Ducks Unlimited. Since Barrow's Goldeneye and Bufflehead are the most common cavity nesting waterfowl species in the Williston area, we expect these two species to be the primary users of nestboxes erected. The nestboxes were placed in marshes where we expected at least one of these two species to be prospecting for nesting cavities. Factors which were taken into account in the assessment of a site for nestbox placement: tree species, tree health, proximity to water, box height, concealment by vegetation, entrance orientation, density of nest structures, availability of forage and loafing areas. We followed available literature on nestbox placement, and also discussed with Ducks Unlimited the guidelines which their organization follows for nestbox instalment.

Table 5. Location and site description for nestboxes installed August, 1992.

TUTUB:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
1	aspen, healthy, mid-slope 30 cm dbh	6m	E	15-17m	cleared extensively dense debris remaining
2	birch, healthy, 30 cm dbh	5m	SE	7m	debris at tree base
3	birch, healthy, spruce snag betw. shore and nest-tree	4m	SE	7m	clear to shore
4	aspen, sign of heart rot	4m	SE	30m	grass and small trees

MUGAHA B:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
5	aspen, healthy, 35 cm dbh, sign of beaver activity	4m	E	30m to sedge 70m to water	small aspen
6	40cm dbh	4m	E	25m to sedge 70m to water	log debris
7	aspen, healthy, 25 cm dbh	3.5m	SE	25m to sedge 50m to water	Pl, S, clear of debris
8	lodgepole pine, 40 cm dbh	4m	S	17-20m	willow, aspen and small pine adjacent

MUGAHA A:

9	birch, healthy, 35 cm dbh, mid-slope (2m)	4m	SSW	6m	alder, aspen, rose, thimbleberry
10	birch, healthy, 32 cm dbh, mid-slope (2m)	3m	SW	5m	pine and birch adjacent, rose, thimbleberry

TUDYAH NORTH:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
11	birch, healthy, 28 cm dbh	4m	SW	3.5m	dense cover of rose, alder and red osier
12	birch, healthy, 29 cm dbh healthy	4m	NE	3m	dense ground cover: high-bush, alder, alder, red osier dogwood
13	birch, healthy, 40 cm dbh beaver sign	5m	WNW	3.75m	high-bush, fireweed, twinflower, lycopodium,
14	birch, healthy, 32 cm dbh	5m	SE	4m	willow, alder, red osier

60 KM MARSH:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
15	birch (forked at base), healthy, 36 cm dbh	4m	S	5m to sedge 10m to water	S, Pl, B, saskatoon, site quite open
16	birch, healthy, 40 cm dbh	5m	SW	15-20m	Pl, S, alder, red osier
17	Pl, healthy, 35-40 cm dbh	5m	SE	12m	Pl, S, rose, Shepherdia, alder cleared along shore
18	Pl, healthy, 35-40 cm dbh	4- 4.5m	S	7m	Pl, twinberry, rose, birch

Table 5 (cont'd). Location and site description for nestboxes installed August, 1992.

ROBERTS POND:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
19	cottonwood, healthy, 70 cm dbh	5m	E	4m	willow, sedge, aspen, Calamagrostis sp.
20	cottonwood, healthy, 50 cm dbh	4.5m	WNW	17m	aspen, twinberry, log debris on ground

WAPOOSE LAKE:

NESTBOX #	TREE DESCRIPTION	BOX HT.	ASPECT	DIST. TO WATER	GROUND COVER
21	aspen, healthy, 45 cm dbh, south of road	3.75m	WNW	15m	Pt, rose, very little debris
22	aspen, healthy, 28 cm dbh, south of road	5m	W	30m	S, aspen, rose, grass, cottonwood, high-bush
23	larch, healthy, 20 cm dbh, north of road	4m	NW	7m	larch, S, rose

Several habitat characteristics surrounding the cavity site might be used as cues by breeding cavity nesters to predict nesting success. These habitat characteristics may include: proximity to nesting conspecific, adjacent habitat structure, environmental disturbance, food supply and foraging substrate, probability of predation or competition, features of the nestbox tree.In general, placement of four nest boxes a on a 5 hectare wetland with average to high habitat quality will not result in crowding. In fact, Ducks Unlimited biologists prefer the nest boxes to be placed on marshes larger than 4 hectares with boxes not closer than 100m if Goldeneye is a target species. Crowding is a concern because nesting barrow's goldeneye and bufflehead are highly territorial (Gauthier and Smith 1987, Savard 1988). Nestboxes placed in the open along shorelines adjacent to brood habitat are more likely to be used than nestboxes placed in dense timber stands. Nestboxes should be within 50m of the wetland margin and be visible from the wetland. Boxes should have a south or southeast aspect and be oriented so they face away from prevailing winds. Cavity nesting waterfowl prefer deciduous trees such as birch or aspen over coniferous trees and the deciduous trees have increased longevity. Branches which obscure the entrance hole should be removed and the ground around the tree clear. Nestboxes should be placed at heights which make them safe from predators. Another aspect of the tree to evaluate when selecting a site for a nest box is the tree health. If nestbox placement is to be a cost effective enhancement technique nestboxes need to be placed in trees which will remain standing for several years.

Using the previously mentioned guidelines we installed the twenty four nestboxes throughout the Williston area. In general we selected deciduous trees with diameters greater than 25 cm and a southeast or southwest aspect. Ideally the trees were within 30m of the wetland and were easily accessible from the water. Appendix 3 indicates the nestbox placement on air photos and maps.

FLOATING ISLANDS

The success of the four floating nesting islands installed in the Tutu and Mugaha areas in 1991, prompted us to expand our use of the islands. We identified four suitable marshes (Table 6) dispersed throughout the Williston basin and purchased four appropriate nesting islands. Wooden floating islands were placed at 60 Kilometre Marsh and Misinchinka marsh

because these marshes are easily accessed by vehicle. The wooden islands are seven square feet, consist of a wooden perimeter and a styrofoam core and covered in wire mesh. Several buckets of dirt are placed on the styrofoam core and it is seeded with half of a pound of grass seed. The island is anchored by two five gallon buckets of cement attached to it by wire cables. The island at 60 Kilometre Marsh is located at the mouth of a small channel approximately 30m from shore. Misinchinka is a smaller marsh and the island is located approximately 10m from shore. Islands made from PVC piping and wire mesh were placed at Tudyah lake and Wapoose lake because these wetlands are not close enough to a road. Cattails serve as the nest material in the PVC islands and they are shoved into the mesh until the PVC is not visible. A large mound of cattails is then placed on the island. The islands at Tudyah and Wapoose are located approximately 25m from shore.

Table 6. Location and water chemistry for floating islands installed August, 1992.

ISLAND LOCATION	ISLAND TYPE	ANCHOR SYSTEM	DEPTH (m)	pH	ALKALINITY (mg/L)	HARDNESS (mg/L)
Tudyah North	PVC	single	11.0	8.0	153.9	153.9
60 Km Marsh	wood	double	2.0	8.0	119.7	119.7
Misinchinka	wood	double	1.7	N/A	N/A	N/A
Wapoose Lake	PVC	single	2.5	8.2	273.6	273.6

* Depths are not absolute due to water level fluctuations.

Canada Geese will be the primary users of the nesting islands, however, other waterfowl such as Mallards and teal, could nest on the islands if the geese do not use them and when they are vacant the islands will serve as a loafing area for migrating waterfowl. The islands were located throughout the Williston area to maximize their potential as geese nesting islands. For example, upland feeding areas and brood rearing habitat for geese were necessary elements of the wetland where they were installed. At the same time, we tried to ensure that floating islands were placed so that feeding areas and natural loafing structures would not be in the territory of a nesting pair.

LOAFING LOGS

Loafing logs are an inexpensive means of improving habitat for waterfowl. The logs provide a resting area for broods which is safe from predators and yet stable. Ten loafing logs were prepared for placement (see Table 6 for a summary of the location sites). A loafing log has been prepared for Mugaha B, however, due to restricted access to the marsh it will be installed by snowmobile this winter. The proposed location will be found at the compass bearings:

1) 210° to the marsh (030° back to the road/gate),
2) 250° to the marsh (70° back to the road/power pole).

Preparation of a loafing log required cutting a pine log 10cm in diameter to a length of 10 to 12m. Metal cables of the appropriate length were then used to attach two cement blocks to the log. With a cement block anchored to each end the log was placed at a site were it could provide a resting area for broods and loafing adults.

BURNING

Dense mats of grass have formed on the Mischinsinlika Foreshore from snow annually compressing tall grasses. Layers of dead grass prevent Canada Geese from foraging on young grass shoots during their spring migration and breeding season. Burning a section of the foreshore would remove the old vegetation and it would open up the area for foraging and possibly nesting Canada Geese. An early spring burn has been planned for 1993 and depending on the results and cost of this burn, future burns would occur annually on adjacent sections of the foreshore. A three to five year burn rotation would maintain suitable habitat for Canada Geese. The preferred method of burning would be a small crew with hand-held drip torches.

In addition to the burn planned in the Mischinsinlika area, a burn has been proposed for parts of Tutu Bay. At Tutu Bay dense grass and wood debris occurs in patches along the timber. Removing the dense mats of grass would create a foraging area for Canada Geese which is currently not available in Tutu Bay. As with the Mischinsinlika burn, the preferred method would be a small crew with hand-held drip torches.

EARTHEN ISLAND

In September 1992 a Ducks Unlimited representative will assist with a blasting project at Mugaha A. The objective of the project is to increase the depth and width of a channel between the shore and a small peninsula. Although a channel currently exists, during low water levels the peninsula is accessible from shore and therefore is not safe from predators. The blasting will create a channel 2m deep, 10m wide and up to 30m long. The resulting island will be L-shaped with a total length of 62m, a maximum width of 20m and will be at least 10m from shore. Aerial photograph BCC930-141 clearly shows the peninsula on the shore opposite the causeway.

3.33 Summary of 1992 Enhancement Projects

In summary, nestboxes, floating islands, loafing logs and blasting were the techniques used to enhance waterfowl habitat at nine wetlands within the Williston Reservoir Basin (Table 7). Four floating nesting islands were installed (2 PVC and 2 wooden) and twenty-four nestboxes were purchased, with all but one being installed. The remaining nestbox will be installed when an appropriate site is located, or be used for display purposes. Ten loafing logs were prepared and nine of the logs have been anchored at appropriate sites. The loafing log allocated to Mugaha B will be installed during this winter. Blasting was conducted in the Blackwater Creek area to improve habitat for aquatic furbearers. Blasting at two different wetlands will provide depressions for waterfowl.

In addition to the wetlands enhancement carried out this summer, plans were made to create a earthen island at Mugaha A, to burn a section of the Mischinsinlika foreshore and to continue aquatic furbearer habitat enhancement. The natural island at Mugaha A will be

created in September 1991 by blasting a channel through an existing peninsula. The foreshore burning will begin this spring and will continue annually depending on results. The ongoing project of enhancing wetlands for aquatic furbearers potentially will benefit waterfowl.

Table 7. Wetland enhancement projects completed in 1992.

LOCATION	NESTBOX	FLOATING ISLAND	LOAFING LOG
Misinchinka Marsh		wooden	1
Mugaha A	2		1
Mugaha B	4		1
Mugaha G			1
Robert's Pond	2		
60 Km Marsh	4	wooden	3
Tudyah North	4	PVC	2
Tutu B	4		
Wapoose Lake	3	PVC	1

3.34 Future Enhancement Projects

Future enhancement efforts should be concentrated on Rocky Marsh as Ducks Unlimited has expressed an interest to coordinate an enhancement project at Rocky Marsh with Williston Wildlife, the District of Mackenzie, and other interest groups. In addition to improving waterfowl habitat, the project could also improve access to the marsh via trails for wildlife viewing opportunities.

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APPENDIX]

BIRD SPECIES CODES-ROYAL B.C. MUSEUM

AMCO	American coot	*Fulica americana*
AMWI	American wigeon	*Anas americana*
BAGO	Barrow's goldeneye	*Bucephela islandica*
BUFF	Bufflehead	*Bucephela albeola*
BWTE	Blue-winged teal	*Anas discors*
CAGO	Canada goose	*Branta canadensis*
CANV	Canvasback	*Aythya valisineria*
CITE	Cinnamon teal	*Anas cyanoptera*
COGO	Common goldeneye	*Bucephela clangula*
COLO	Common loon	*Gavia immer*
COME	Common merganser	*Mergus merganser*
EUWI	Eurasian wigeon	*Anas penelope*
GADW	Gadwall	*Anas strepera*
GRSC	Greater scaup	*Aythya marila*
GWTE	Green-winged teal	*Anas crecca*
HARL	Harlequin duck	*Histrionicus histrionicus*
HOGR	Horned grebe	*Podiceps auritus*
HOME	Hooded merganser	*Lophodytes cucullatus*
LESC	Lesser scaup	*Aythya affinis*
MALL	Mallard	*Anas platyrhynchos*
NOPI	Northern pintail	*Anas acuta*
NOSH	Northern shoveller	*Anas clypeata*
REDH	Redhead	*Aythya americana*
RNDU	Ring-necked duck	*Aythya collaris*
RNGR	Red-necked grebe	*Podiceps grisegena*
SNGO	Snow goose	*Chen caerulescens*
SUSC	Surf scoter	*Melanitta perspicilatta*
TRSW	Trumpeter swan	*Cygnus buccinator*
WODU	Wood duck	*Aix sponsa*
WWSC	White-winged scoter	*Melanitta fusca*

APPENDIX 2

Calculation of Breeding Pairs From Groups

All Dabblers:

- Drakes in groups of two or three each represent one pair.
- Groups of three to six, including one female represent one pair. (i.e., 2/1, 3/1, 4/1, 5/1)

Canvasback, Redhead, Ring-necked Duck, Scoter, Merganser, Ruddy:

- Groups of three to six, including one female represent one pair, (i.e., 2/1, 3/1, 4/1, 5/1)

Bufflehead, Goldeneye:

- Heterogenous groups of three represent one pair, (i.e., 2/1, 1/2)

Scaup:

- Groups of two drakes and one hen represent one pair.

APPENDIX 3

AERIAL PHOTOGRAPHS OF STUDY AREA

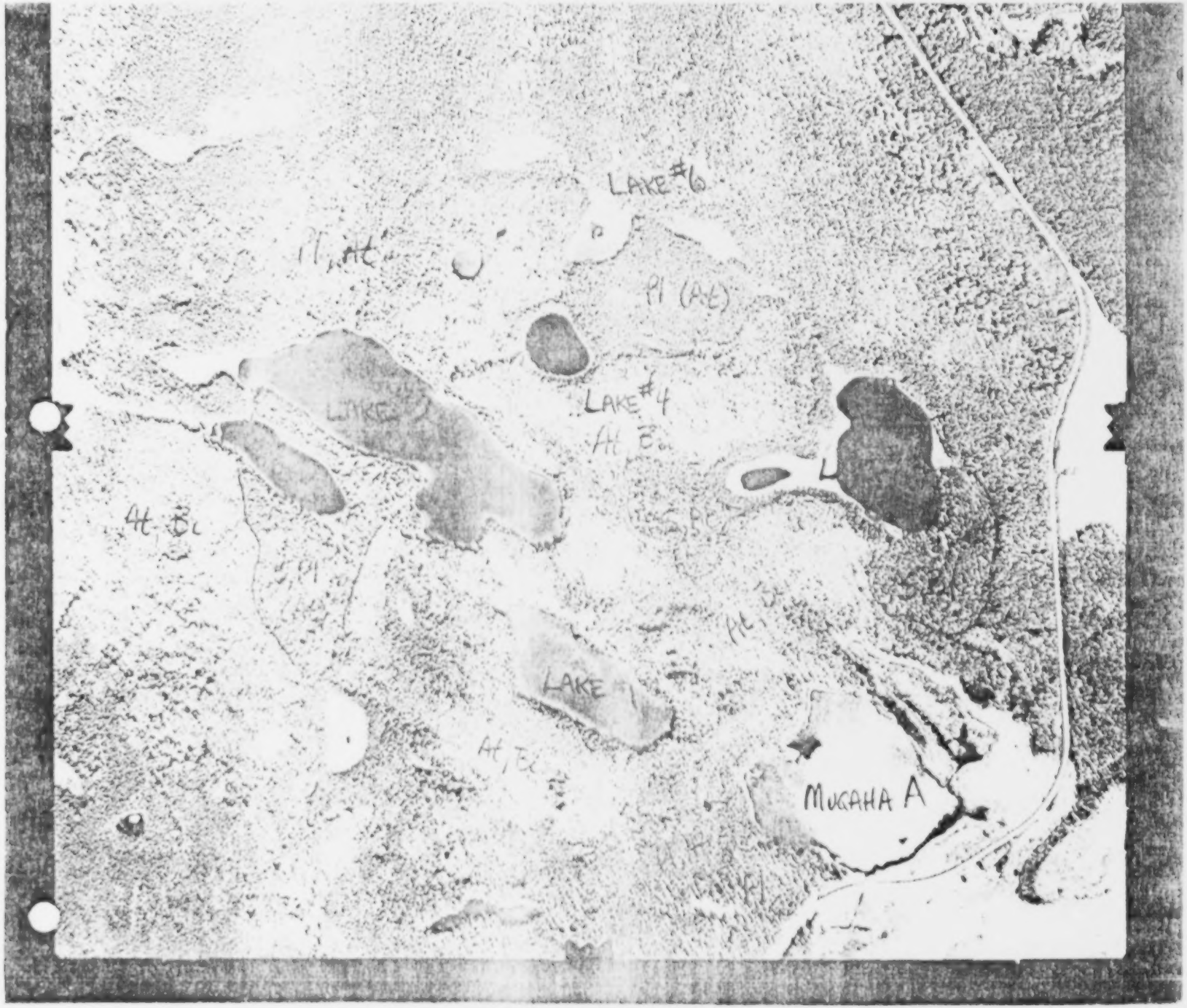
BCC932-197 Misinchinka Marsh
BCC931-165 SITE 1, Mischinsinlika and Parsnip River
BCC930-52 SITE 2, Buth marsh
BCC930-59 Rocky Marsh
BCC930-60 Rocky Marsh
BCC930-61 Rocky Marsh
BCC930-141 Mugaha Area
BCC930-143 Mugaha Area
BCC930-173 Mugaha Area
BCC930-175 Mugaha Area
BCC930-177 Mugaha Area
BCC930-197 Mugaha Area and lakes
BCC930-180 Tutu Area and Lakes
BCC930-182 Tutu Area
BCC930-184 Tutu Area

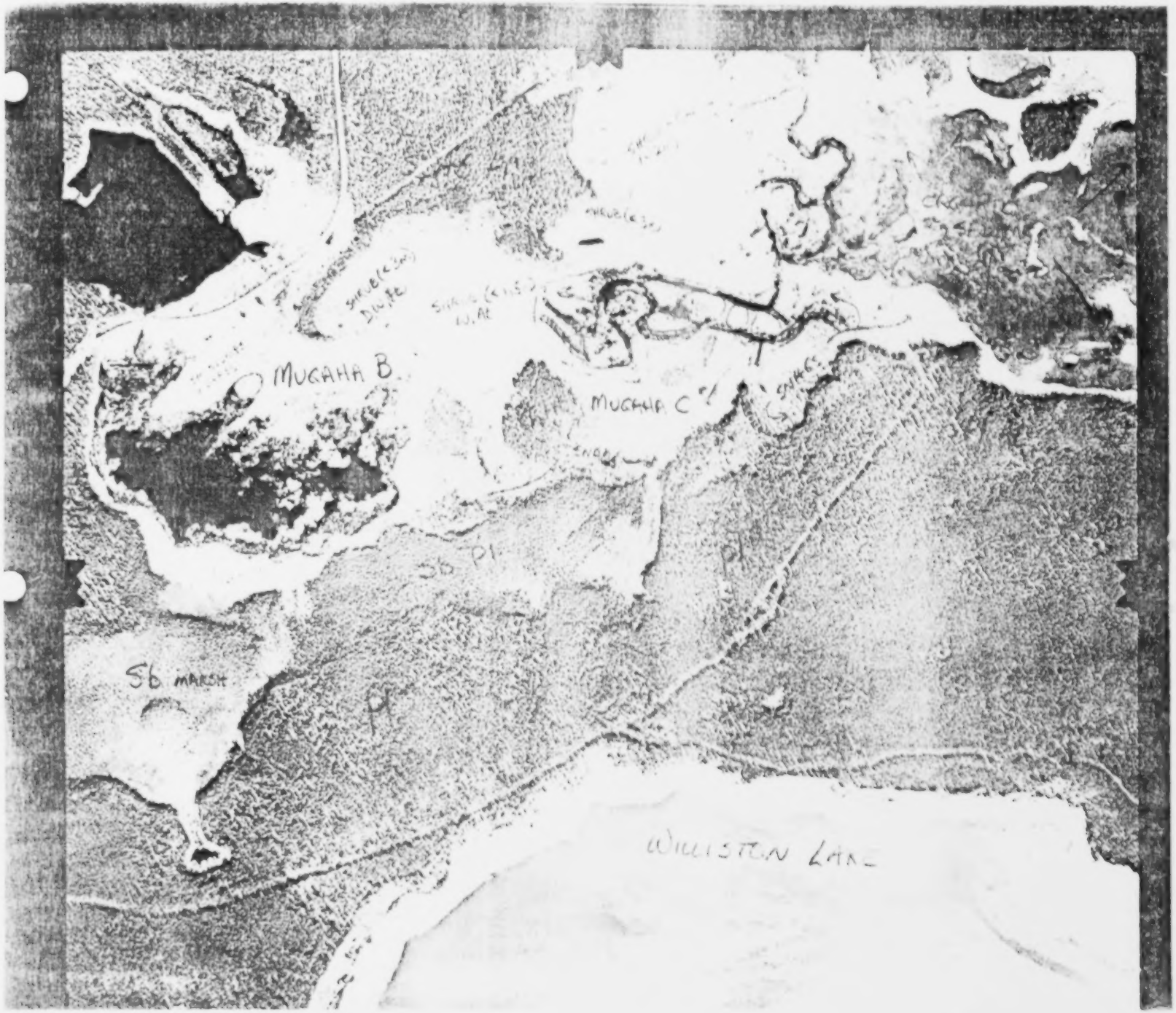
Province of British Columbia
30 BCC930-184
TUTU CREEK
TUTU F
TUTU G
SITE
TUTU D
660m
640m
620m
600m
SITE
Sb
TUTU B
TUTU A
TUTU L
TUTU E
CUTBLOCK

AD A090 182

30-BGE30-180

WILLI FEN


LAKE #6
Pl (At)
LAKE #4
At Bc
LAKE
At Bc
MUGAHA A


MUCAHA B
MUCAHA C
Sb MARSH
WILLISTON LAKE

MUSHA E
MUSHA F

MOUNTAIN BAY

Site 1 (MECHANSIKA PEKESHORE)

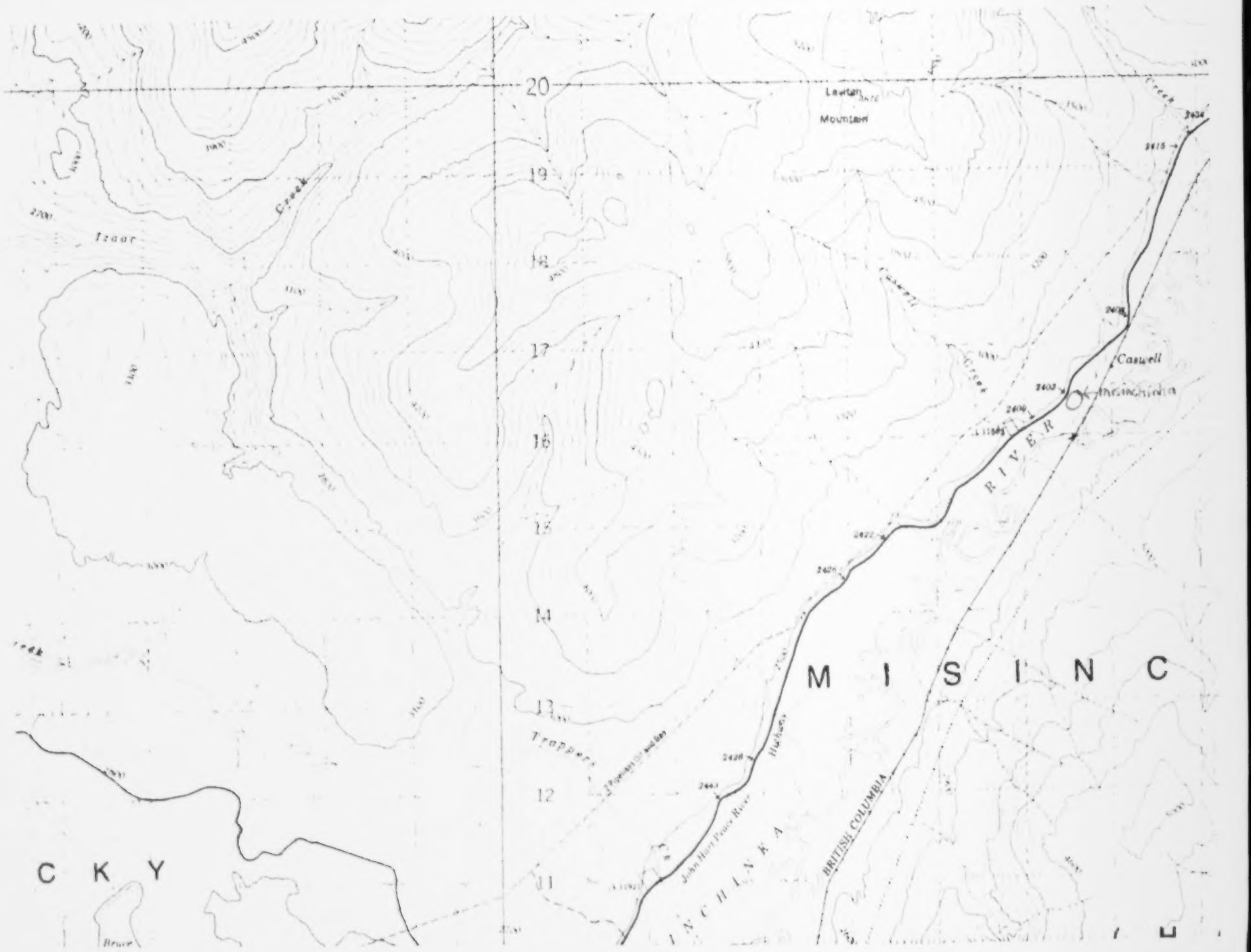
Site 2 (North Marsh)

30 BCC932-194

Rocky Mesa
30 Bergen-60

30 BCC930-61
Rocky
Mtn

ROBERT'S ISLAND.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11
Lawton
Mountain
Creek
Izaar
Caswell
Creek
RIVER
Caswell
M I S I N C
Trappers
Harbour
BRITISH COLUMBIA
C K Y
Bruce

60 Mile marsh
HEATH
POIN
F I N L A Y
F

TRENCH
PARSNIP
FRASER
FOREST
LAKE

GLOSSARY GLOSSAIRE

ABBREVIATIONS ABREVIATIONS